1454597

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO A METHOD OF PRILLING AND DEVICE FOR CARRYING OUT THE METHOD

(71) We, VEREINIGTE ÖSTERREICHISCHE EISEN — UND STAHLWERKE — ALPINE MONTAN AKTIENGESELLSCHAFT, a company organised under the laws of Austria, of, Werksgelände 4010 Linz, Austria, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The invention relates to a method of prilling liquids, in particular melts, whereby the liquids are divided into uniform drops.

In known prilling methods, e.g. in the production of prilled ammonium nitrate, the ammonium nitrate melt is normally sprayed through sprinkling nozzles into a shaft, where the drops solidify when falling; after cooling they are delivered as hard prills at the lower end of the shaft. The air warmed by the emitted heat is sucked off at the upper end of the shaft.

When the jet emerging from the nozzle holes disintegrates into the prill drops, because of the mechanics of liquids, very small drops are always formed in addition and these drops, due to their low weight, are carried away in the shaft by the air current and are discharged as dust through the fans. In commonly used plants this dust amounts to approximately 0.2 per cent of the production and hardly counts as a production loss, but because of its aggressive nature, this dust can cause heavy damage to buildings; in addition, because of its high nitrogen content it may cause serious ecological damage.

It is known to set thread-like liquid jets vibrating, in order to obtain a more uniform distribution into drops. Thus it is known from the German Auslegeschrift No. 1,803,724 to retain a circular perforated plate elastically as the bottom of a container or housing and to set it vibrating via a laterally welded handle by means of a vibrator. Thereby a pressure wave forms above the plate, which modulates the plate frequency and causes periodical disturbances of the liquid which lead to the constriction and subsequent disintegration of the jets. This known device has however the disadvantage that the vibration frequency has to be matched with the inherent frequency of the perforated plate and that the vibration-exciting force is brought in unilaterally via the welded handle, which results in a bending moment. As a result, an uneven amplitude distribution occurs on the perforated plate and in places top oscillations occur, so that for different jets different conditions prevail, which lead to irregularities and to fine grain content. Further disadvantages are that by fixing the plate to the container, a loss of effectiveness occurs and the sealing along the fixing is not reliable; as the contact areas between the perforated plate and the housing have to be of metal. It is also very difficult to clean the perforated plate.

The invention has the object of avoiding the above mentioned disadvantages and difficulties; it aims at providing a method, in which the frequency of the vibrations acting upon the thread-like jets is optimally variable, an extremely uniform granulation of the prills with a narrow grain spectrum is achieved, the formation of fine grains is avoided and production losses as well as damage to buildings and fields is prevented.

According to the present invention, there is provided a method of prilling a liquid, in particular a melt, in which the liquid is passed under pressure through a perforated plate, wherein the liquid is subjected to periodical pressure fluctuations in the direction of its flow through the perforated plate before it passes through the plate, and the frequency of these pressure fluctuations, in dependence upon the exit velocity v in m/sec and upon the perforation diameter d in mm substantially follows the relation

$$f = \frac{v \cdot 1000}{\pi \cdot d}$$

and is in the range of 100 to 2000 Hz.

This formula constitutes an approximate relation which is applicable to liquids whose viscosity corresponds approximately to that of water. For liquids with a higher viscosity,

values of f may be chosen which lie up to 10% lower, and vice versa for liquids with a lower viscosity than that of water, where frequencies have to be applied which may lie up to 10% above the approximate value. The vibrations may be sinusoidal, but especially favourable results are achieved according to the invention, if a saw-toothed amplitude is chosen for the above mentioned vibrations, i.e. an amplitude which rises more steeply than it falls.

The invention also includes a suitable device for carrying out this method, comprising a housing for the liquid to be prilled having a base comprising a fixed perforated plate through which the liquid can pass, and a vibration generator including a vibration plate reciprocable normal to itself located parallel to and spaced from the perforated plate, the housing having the form of a spiral and being provided with a tangential liquid inlet, and liquid current guiding means being arranged within the housing and extending radially in relation to the centre of the perforated plate.

Further advantageous embodiments of the device according to the invention consist in that the vibration generator is connected with the vibration plate by a mechanically rigid connection such as a shaft, and the upper part of the housing is suitably sealed from the vibration plate or the shaft with an elastic seal. The perforated plate and the vibration plate are suitably circularly shaped and have substantially equal diameters. Advantageously the current-guiding means, comprise laminas, and between the inlet of the liquid into the housing and the perforated plate, one or more filters or sieves are installed; preferably such a filter is a cylindrical sieve surrounding the liquid current-guiding means. According to a preferred embodiment the vibration plate is arranged between the perforated plate and the housing cover and is also provided with perforations, which preferably have a larger diameter than that of the perforations of the perforated plate.

The invention will now be illustrated in more detail by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a side view;

Fig. 2 is a horizontal section along line II—II of Fig. 1;

Figs. 3 and 4 show similar views of a modified embodiment;

Fig. 5 illustrates the pressure wave which results in the embodiment according to Figs. 1 and 2, and

Fig. 6 shows a similar illustration of the pressure wave for the embodiment according to Figs. 3 and 4.

The device comprises a spiral shaped housing 1 having a tangential inlet 2, and a cylindrical filter or sieve 3 located centrally between the central interior of the housing and the spiral-shaped outer wall. The bottom of the housing is formed by a peripheral inlet base part 5 and a central perforated plate 4 rigidly fixed to the part 5 so that it does not vibrate. The perforated plate is provided with a plurality of perforations 6, through which a liquid that is to be prilled emerges in a manner that will be described hereinafter. At a peripheral inlet top part 7, a vibration plate 8 is connected to an elastic annular seal 9, so that the vibration plate lies at a distance from the perforated plate and parallel in relation thereto. The vibration plate 8 is rigidly connected to a vibration generator 11 via a shaft 10. Between the sieve 3 and the perforated plate 4, the base part 5 possesses radially arranged laminas 12, which serve for guiding the liquid and for avoiding transverse currents. When the vibration plate 8 is caused to vibrate, a pressure wave emanates periodically from the plate, and this wave is reflected at the perforated plate 6, runs back to the vibration plate 8 and is again reflected therefrom, the vibration strength diminishing rapidly with each reflection. The pressure waves that are produced and reflected become superimposed and as a result a pressure wave is formed acting upon the perforated plate, which pressure wave is slightly out-of-phase in relation to the vibration waves of the vibration plate. The degree of phase displacement depends upon the distance of the perforated plate from the vibration plate and upon the sound velocity in the liquid. It amounts for example to 30 angular degrees. When applying the relation referred to previously between frequency, exit velocity and perforation diameter, the liquid jets emerging from the perforations show a very uniform rotationally symmetrical wave formation. The constriction points constitute the predetermined disintegration lengths. The deformation of the jets is so strong that the preformed drops, lined up one next to the other in a similar manner to a string of pearls, with only very narrow connections in between, emerge from the perforations of the perforated plate and separate very rapidly without fine grains being formed.

Fig. 5 illustrates schematically by means of arrows the propagation of the pressure wave D when operating the above described device.

The embodiment according to Figs. 3 and 4, in which similar parts bear similar reference numerals, varies from the first embodiment in that the vibration plate 8 is arranged close to the perforated plate 4, i.e. in the interior of the housing, and in that the shaft 10 forming the connection to the vibrator 11 passes through the annular elastic seal 9 covering the upper part of the housing, which seals off the top part 7. Another difference consists in that the vibration plate 8 is itself provided with perforations 13. In this embodiment, transverse currents at the perforated plate are avoided and the result is an improved pressure wave propagation as well as a

reduced phase displacement between vibration plate and perforated plate. The pressure wave has the form illustrated in Fig. 6.

The method of the invention and the device described above are used with advantage in the production of artificial fertiliser. The following examples illustrate the prilling of ammonium nitrate and urea.

Example 1:

Ammonium nitrate having a melting point of 183°C is melted and is inserted into the device at a pre-pressure of 3 m liquid column. The average exit velocity is 4.3 m/sec and the diameter of the perforations in the perforated plate is 1.25 mm. The vibration frequency to be applied is

$$f=\frac{4.3\times 1000}{1.25\times\pi}=1{,}100\text{ Hz.}$$

It has shown that in this way optimum prilling results can be achieved, i.e. one obtains very uniform grains with an average diameter of 2.1 mm without practically any fine grains.

Example 2:

Urea with a melting point of 145°C is melted and passed through the device at a pre-pressure of 2 m liquid column; the resulting average exit velocity is 3.5 m/sec; the perforation diameter is 1 mm; the frequency from the above relation

$$f=\frac{3.5\times 1000}{1.0\times\pi}=1{,}120\text{ Hz}$$

Also in this case extremely uniform grains with an average diameter of 1.7 mm were obtained and no dust content could be observed.

WHAT WE CLAIM IS:—

1. A method of prilling a liquid, in particular a melt, in which the liquid is passed under pressure through a perforated plate, wherein the liquid is subjected to periodical pressure fluctuations in the direction of its flow through the perforated plate before it passes through the plate, and the frequency of these pressure fluctuations, in dependence upon the exit velocity v in m/sec and upon the perforation diameter d in mm substantially follows the relation

$$f=\frac{v\,.\,1000}{\pi\,.\,d}$$

and is in the range of 100 to 2000 Hz.

2. A method as claimed in Claim 1, wherein the periodical pressure fluctuations are saw-toothed or sinusoidal vibrations.

3. A device for carrying out the method as claimed in Claim 1 or Claim 2, comprising a housing for the liquid to be prilled having a base comprising a fixed perforated plate through which the liquid can pass, and a vibration generator including a vibration plate reciprocable normal to itself located parallel to and spaced from the perforated plate, the housing having the form of a spiral and being provided with a tangential liquid inlet, and liquid current guiding means being arranged within the housing and extending radially in relation to the centre of the perforated plate.

4. A device as claimed in Claim 3, wherein one or more filters are located between the liquid inlet and the perforated plate.

5. A device as claimed in Claim 4, wherein said one or more filters comprise a cylindrical sieve surrounding the liquid current guiding means.

6. A device as claimed in any of Claims 3 to 5, wherein the vibration plate is connected to the vibration generator by means of a mechanically rigid connection in the form of a shaft.

7. A device as claimed in Claim 6, wherein the vibration plate forms part of an upper wall of the housing and is sealed against the upper part of the housing by elastic sealing means.

8. A device as claimed in Claim 6, wherein the vibration plate is located between the perforated plate and the upper wall of the housing and the shaft passes through an opening in the upper wall of the housing.

9. A device as claimed in Claim 8, wherein the shaft is sealed against the upper part of the housing by elastic sealing means.

10. A device as claimed in Claim 8 or Claim 9, wherein the vibration plate is provided with perforations which preferably have a larger diameter than the perforations in the perforated plate.

11. A device as claimed in any of Claims 3 to 10, wherein the perforated plate and the vibration plate are circular and have substantially equal diameters.

12. A device for carrying out the method as claimed in Claim 1 or Claim 2, substantially as hereinbefore described with reference to Figs. 1, 2 and 5 or Figs. 3, 4 and 6 of the accompanying drawings.

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 1

FIG.1

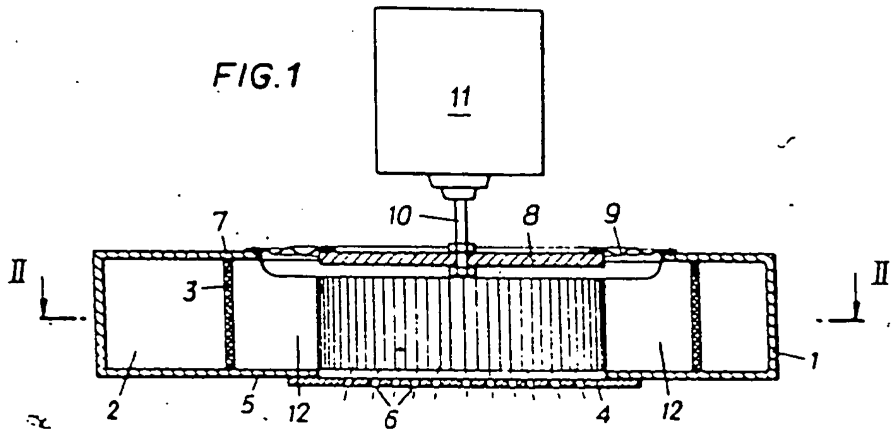


FIG.2

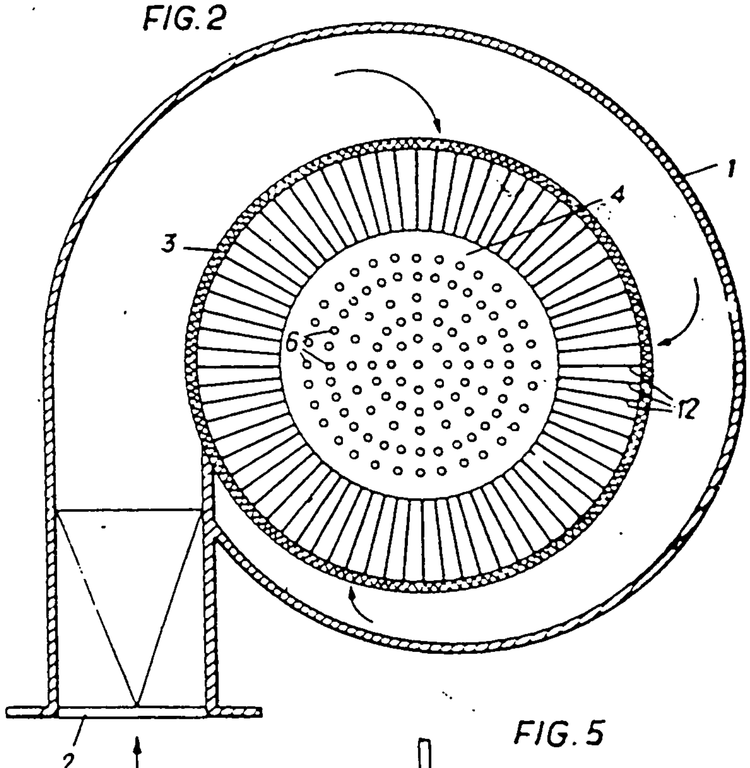
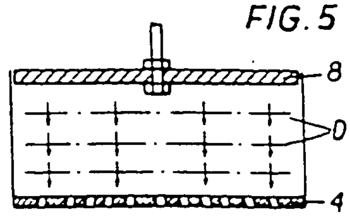


FIG.5



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2 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 2

FIG. 3

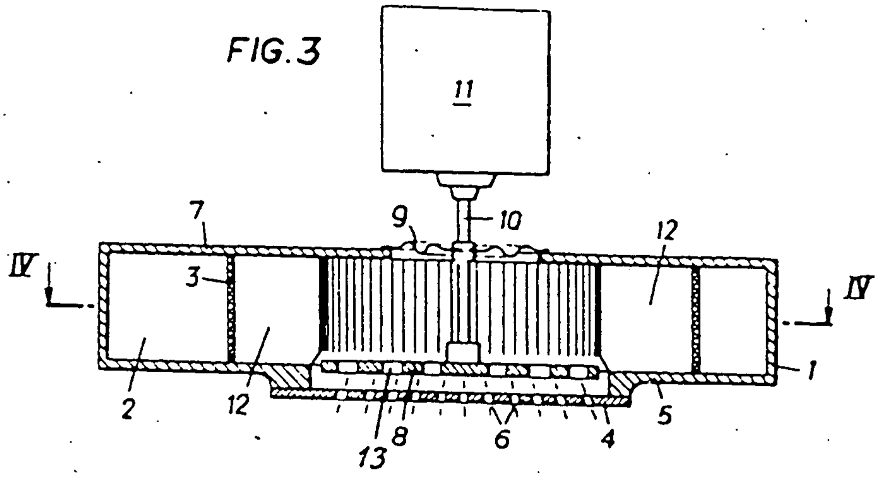

FIG. 4

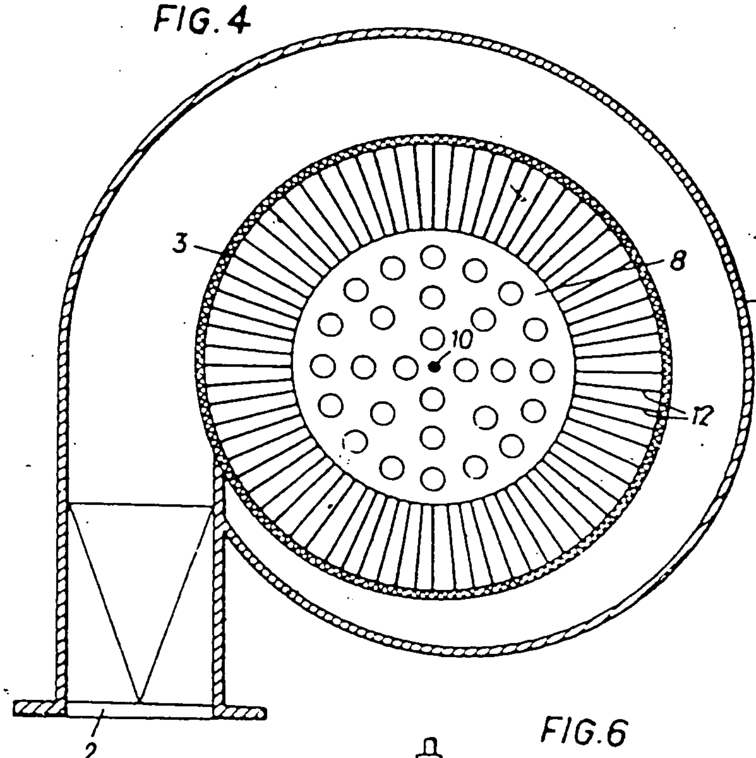

FIG. 6